DRAFT ENVIRONMENTAL IMPACT STATEMENT

for

STILLWATER MINING COMPANY
OPERATING PERMIT No. 00118
AMENDMENT 009

UNDERGROUND VALLEY CROSSING and MINE PLAN

Prepared by

MONTANA
DEPARTMENT OF ENVIRONMENTAL QUALITY
RECLAMATION DIVISION/HARD ROCK BUREAU

October 16, 1995

EXECUTIVE SUMMARY

On April 7, 1995, the Department of Environmental Quality Reclamation Division/Hard Rock Bureau (DEQ RD/HRB) received an application to amend operating permit #00118 from Stillwater Mining Company. This proposed amendment to the permit addresses SMC's wish to connect the East and West mining areas by way of a haulage drift located at the 4400 foot level. The haulage way would be developed beneath the Stillwater River and its flood plain. SMC proposes to connect mining operations on both sides of the Stillwater River Valley through construction of an underground haulage level at the 4400 foot elevation.

The purpose of this Amendment to Stillwater Mining Company's Plan of Operation is to provide an underground connection between the East and West mining areas. This would be via a haulage drift driven on the 4400 level, developed in part under the Stillwater River. Secondarily SMC may, upon approval of the plan, mine the ore body at and below the 4400 level if and when mineralization is defined.

The approval of this Amendment would provide SMC with the means to reduce ore and waste handling costs while increasing the ore reserves available for mining. SMC plans to implement this Amendment in two distinct phases. Phase one, which is the primary thrust of this Amendment, would include completion of 4400 haulage level and the diamond drilling necessary to define the mineralization. Phase two would involve implementation of the mining plan below the surface crown pillar. Approval of this Amendment would allow SMC to reduce ore and waste handling costs by shortening haulage distances to the mill, enable SMC to crush the ore prior to reaching the mill, enable SMC to access and further delineate additional ore reserves, and to reduce conflict with recreational traffic using County Road 419.

The analysis indicates that the proposed crown pillar thickness (200ft) is adequate. The long-term stability of the pillar is not considered to be an issue, particularly because SMC proposes to backfill the 4400 haulageway level at closure where it is adjacent to the base of the crown pillar. In addition all stopes would be backfilled upon completion of mining.

Inflows to the proposed 4400 haulage level are expected to be through fractures. These fractures may have some connection to the overburden soils, but their low permeability would limit the inflow volumes. Inflows from these features are expected to be on the same scale as the flows currently observed in the East Side Mine. The prediction rate of the inflow to the haulageway (200 gpm) is not expected to have any impact on flow in the Stillwater River or groundwater levels in the valley.

Groundwater and surface water quality are not expected to change following the implementation of this proposal. Mine production rates and the associated nutrient loading from mining activities would not be increased by way of this amendment and would not exceed the levels analyzed in the SMC 2000 EIS.

TABLE OF CONTENTS

CHAPTER I PURPOSE AND NEED FOR ACTION

A. PROPOSED ACTION

On April 7, 1995, the Department of Environmental Quality Reclamation Division/Hard Rock Bureau (DEQ RD/HRB) received an application to amend operating permit #00118 from Stillwater Mining Company (SMC). Under this proposed amendment to the permit, SMC's would connect the East and West mining areas with a haulage drift located at the 4400 foot level. SMC proposes to connect mining operations on both sides of the Stillwater River Valley through construction of an underground haulage level at the 4400 foot elevation. The haulageway would be developed beneath the Stillwater River and its flood plain.

This amendment to the operating permit has been submitted as an appendix (Appendix H) and supplemental pages to the 2000 TPD Plan of Operations approved 9/23/92.

B. PURPOSE AND NEED

Approval of this amendment would allow SMC to reduce ore and waste handling costs by shortening haulage distances to the mill, to crush the ore prior to reaching the mill, enable SMC to access and further delineate additional ore reserves, and to reduce conflict with recreational traffic using County Road 419.

C. PROJECT LOCATION AND BACKGROUND

The Stillwater Mining Company (SMC) operates an underground platinum/palladium mine in Stillwater County, Montana (Figure 1

The closest community is Nye, approximately 5 miles northeast of the mine site.

SMC has been permitted to operate the mine with an ore production rate averaging 730,000 tons per year (tpy), or 2,000 tons per day (tpd). Currently, ore production rates are 1,050 tpd. The ore is upgraded on site by crushing, grinding, floating, and drying to a concentrate. The crushing facilities are currently located on the surface (Figure 2). Approximately 57 percent of tailing created during the milling process is returned underground for use as backfill in mined out stopes. The remaining 43 percent is disposed of in a lined tailing impoundment adjacent to the mine and mill facility. The dried concentrate is shipped by truck to a smelter located in Columbus, Montana, for further processing and is subsequently shipped to Belgium for refining.

SMC's original plan of operations was approved after completion of a Final Environmental Impact Statement, jointly written by the Montana Department of State Lands and the Custer National Forest (DSL/FS, 1985). The current proposal, if approved, would be the ninth amendment to the original plan of operation and permit. The following is a summary of all previously approved changes to the plan of operations.

Amendment 001 - Approved and permitted June 30, 1986. This amendment relocated mine and mill facilities. No increase in permit area or disturbed area resulted.

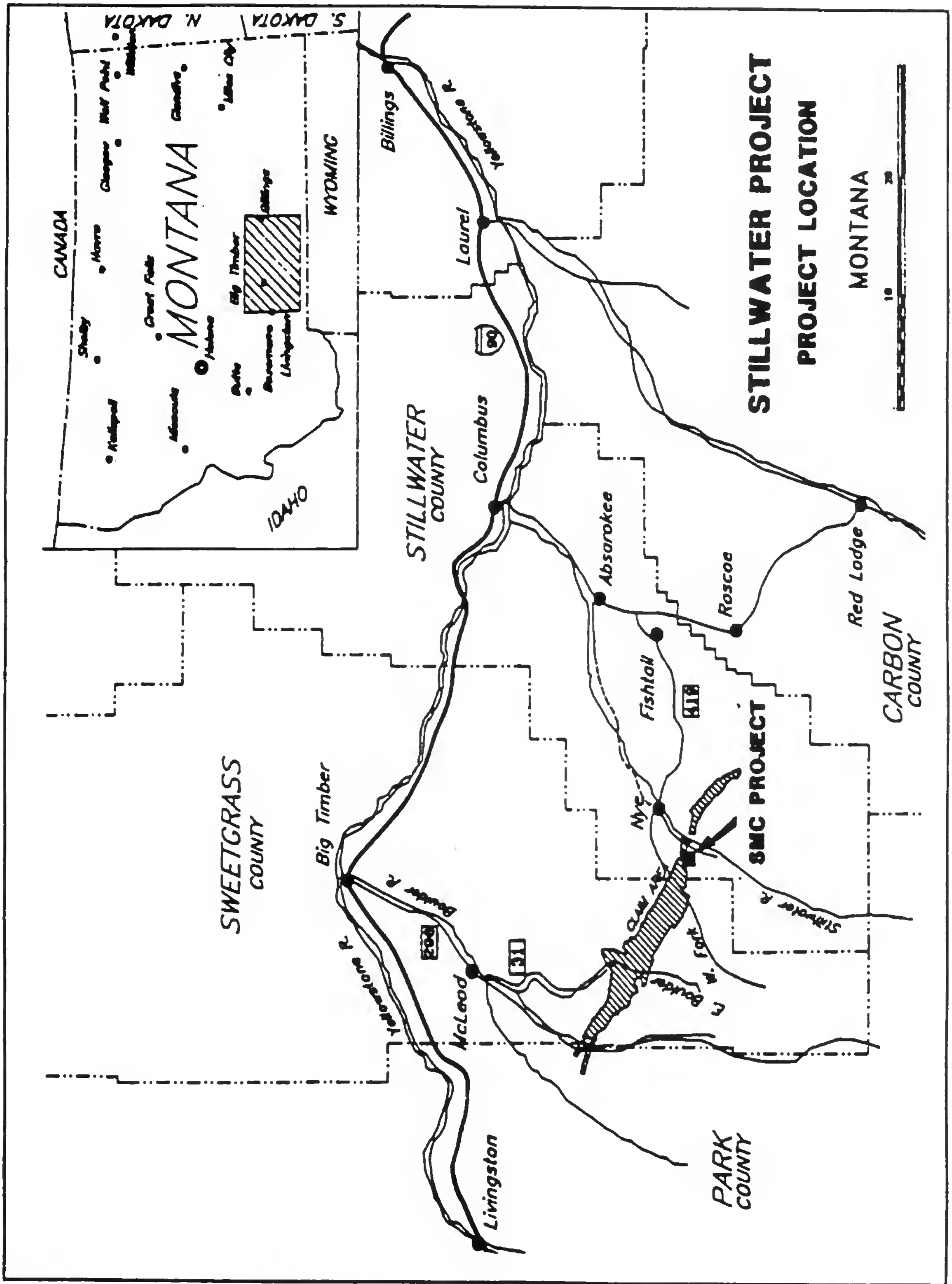
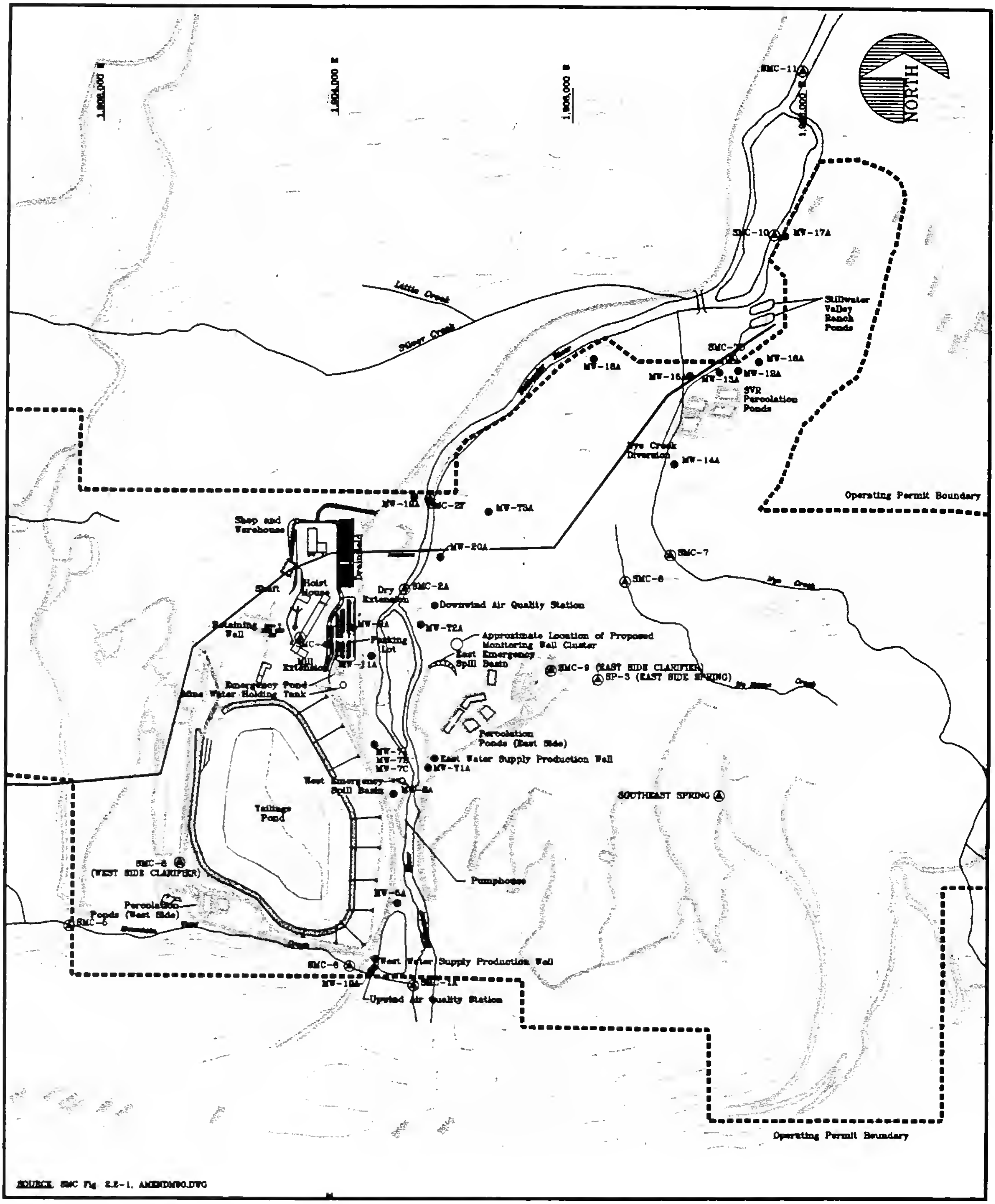


Figure 1 Stillwater Project Location



SCALE
(In Feet)
600 0 600

Legend
SMC-6 Surface Water Monitoring Site
MW-10A Groundwater Monitoring Site

Stillwater Mine Area and Water Resources Monitoring Sites

Underground River Crossing EIS
Stillwater Mining Company

Dwg. No: SMC-9501 Date: 10/11/95

LAST UPDATE: 9:20AM
131\080\0037\HEL\951012\\I:\TRANSFER\SMC-9501.DWG

Figure 2

Amendment 002 - Approved and permitted September 8, 1986. This amendment allowed excavation of a sand borrow area in an existing permit area. The disturbed area has been reclaimed.

Amendment 003 - Approved and permitted January 8, 1987. This amendment allowed excavation of a second sand borrow area. Within the permit area and the disturbance has been reclaimed.

Amendment 004 - Approved and permitted February 24, 1987. This amendment relocated the southern portion of the tailing impoundment toe dike within the permit area. This amendment shifted the toe dike to higher ground along Mountain View Creek and previously disturbed land.

Amendment 005 - Approved and permitted March 2, 1989. This amendment was the first major amendment since the original permit. It increased the permitted area to 1,158 acres and permitted mining on the east side of the Stillwater River. The total allowable disturbance was increased by 72 acres.

Amendment 006 - Approved and permitted July 21, 1989. This amendment was for construction of a temporary sand slurry pipeline connecting the east and west sides of the mine area. No increased permit or disturbed area was allowed.

Amendment 007 - Approved and permitted November 15, 1990. This amendment was for construction of the three Stillwater Valley Ranch percolation ponds and 4 monitoring wells. The permit area was increased 27 acres with 7 acres of disturbance.

Amendment 008 - Approved and permitted on September 23, 1992. Under this amendment, production was permitted to

increase from 1000 tons per day (TPD) to 2000 TPD. Some expansion of support facilities such as waste dumps, the mill, and the tailing impoundment was also approved.

In addition, SMC's minor amendment to relocate the 5900 adit southward onto private land to visually hide it from almost all public view was approved. The permit area was extended by 48 acres with 2 acres disturbed.

Currently the total permit area is 1233 acres with 245 acres permitted for disturbance. However, because of ongoing reclamation and staged development, only 117 acres are currently disturbed. MDSL-USFS, 1985; MDSL-USFS, 1989; MDSL-USFS, 1992 are incorporated by reference into this environmental analysis.

D. SCOPING PROCESS

An interdisciplinary team composed of DEQ/HRB engineers, hydrologists, and reclamation specialists preliminarily defined the issues and alternatives. Public notice of receipt of the application was published in the Stillwater Sun and the Billings Gazette. Individual scoping letters were sent to the entire public mailing list, soliciting comments. In response, 11 letters were received. These responses were used to refine the issues and alternatives. All issues identified through the public scoping process are addressed.

1. Issues Identified and Eliminated

Two issues identified during the scoping process are referred to the 1992 EIS Foreseeable Activities. Concerns expressed about an increase in the tailings

impoundment and an increase in employment are not readdressed here. The ore body continues to extend approximately 27 miles and SMC continues to commit to incremental development consistent with state law. SMC has not proposed any change in either employment or production rates. If and when SMC applies for future amendments to the permit, the effects of the specific proposals such as additional tailing impoundments would be evaluated. Site alternatives described in (MDSL-USFS, 1985) are still foreseeable. Specific impacts described in that EIS remain unchanged until SMC submits a detail site proposal. As long as employment remains unchanged, social economic effects described in MDSL-USFS, 1992 would not change as a result of continued mining.

2. Significant Issues

Issues identified during the scoping process that have been determined to be significant revolve around water quantity and water quality with crown pillar stability a parallel issue. Specifically, the issues are:

a. Crown pillar stability: Concerns focus on potential for disruptions of the river should the crown pillar be unstable.

b. Water quality of the Stillwater River and the Stillwater valley aquifer. Concerns focus on the potential for increased nitrate loading.

c. Water quantities of the Stillwater River and its aquifer. Concerns revolve around changes in flow

in the river as well as changes in groundwater levels.

E. AGENCY ROLES AND RESPONSIBILITIES

The Montana Department of Environmental Quality is the lead agency for this EIS. However, several federal and state regulatory agencies are involved in the review of this EIS.

1. Department of Environmental Quality

a. Reclamation Division - Hard Rock Bureau

The Director of the Department of Environmental Quality must decide whether to approve the project as applied for, approve alternative plans, approve subject to modification through stipulations, or deny the permit as required by the Montana Metal Mine Reclamation Act (MMRA)(Title 82, Chapter 4, Part 3, MCA).

The Reclamation Division's Hard Rock Bureau administers the MMRA which applies to all state, federal and private lands. The purpose of the act is to provide that the usefulness, productivity, and scenic values of all lands and surface waters involved in mining and exploration receive the greatest reasonable degree of protection and are reclaimed to beneficial use. The act and its regulations (ARM 26.4.101 et seq.) set forth the steps to be taken in the issuance of an operating permit for and the reclamation of the applicant's proposed mine expansion.

DEQ - Reclamation Division's rules (ARM 26.2.601 et seq.) implementing MEPA (Title 75, Chapter 1, MCA) also require preparation of an environmental analysis. The Department has determined that an Environmental Impact Statement (EIS) is appropriate for this project. This EIS has several purposes:

(1). It serves to ensure that the agency uses the natural and social sciences and the environmental design arts in planning and decision-making;

(2). It assists in the evaluation of reasonable alternatives and the development of conditions, stipulations or modifications to be made part of a proposed action;

(3). It ensures the fullest appropriate opportunity for public review and comment on proposed actions, including alternatives and planned mitigation; and

(4). It examines and documents the effects of a proposed action on the quality of the human environment, and provides the basis for public review and comment.

The Director may deny a permit when it can be demonstrated that air and water statutes cannot be complied with and/or the reclamation plan as proposed is not feasible (82-4-351, MCA). A permit may also be denied if a person, or any firm or business association of which that person was a principal or controlling member has a bond forfeited (82-4-360, MCA) or may be denied

for failure to reclaim an operation (82-4-341(6), MCA). SMC has not forfeited any bonds under the MMRA and has not failed in its reclamation obligations.

Reclamation bonding is also determined by DEQ under MMRA. Reclamation bonds are determined by computing costs to the State of reclaiming a site should the operator default. After an application has been approved and mitigation measures are identified, the bond is calculated based on the approved and permitted specifications. The bond would include long-term maintenance of water treatment facilities such as percolation ponds and diversion ditches, demolition of buildings and other facilities, earth movement and soil replacement, seedbed preparation and revegetation. Once bond is submitted by the applicant, the permit would be issued.

b. Water Quality Division

The Water Quality Division (WQD) is responsible for administering several state statutes including the Public Water Supply Act (Title 75, Chapter 6 MCA), Sanitation and Subdivisions Act (Title 76, Chapter 4 MCA) and the Water Quality Act (Title 75, Chapter 5 MCA). The WQD also administers several sections of the federal Clean Water Act pursuant to an agreement between the State of Montana and the Environmental Protection Agency (EPA). The State of Montana, through the WQD, has been delegated authority for administration of the Nonpoint Source Pollution Program (319), National Pollution Discharge Elimination System (NPDES), and Water Quality Standards (CWA section 307).

The Water Quality Act (WQA) provides a regulatory framework for protecting, maintaining and improving the quality of water for beneficial uses. Pursuant to the WQA, the WQD has developed water quality classifications and standards, and a permit system to control discharges into state water. Mining operations must comply with Montana surface and groundwater regulations and standards. SMC currently holds a Montana Pollution Discharge Elimination System (MPDES) permit (MT-0024716) for discharge of excess adit water into the Stillwater River.

2. U.S. Forest Service

The Forest Service has authority for regulating all activities and uses of national forest system lands. The Forest Supervisor can decide to approve the amendment to the plan of operations as submitted, approve the amendment to the plan with modifications or mitigation measures, or notify SMC that the amendment can not be approved until an environmental impact statement has been prepared (36 CFR 228).

The 1872 General Mining Law, as amended, grants all US citizens the right to locate and develop a mining claim on national forest system lands open to mineral entry. At the same time, the Organic Administration Act of 1897 authorizes the Secretary of Agriculture to regulate occupancy and use of the national forest resources. The regulations (36 CFR 228) pertain to all national forest users who operate under the mining laws. The Forest Service retains the right to manage and dispose of surface resources on unpatented mining claims to the extent that this does not unreasonably interfere with mining activity.

The U.S. Forest Service management policy for mining activity originates from the 1872 General Mining Law, as amended, the Mining and Mineral Policy Act of 1970, the National Materials and Minerals Policy, Research and Development Act of 1980, and a number of executive orders. It is National Forest Service policy to encourage the exploration, development, and production of mineral resources on all lands open to mineral entry.

The area involved in this proposal is within Management Area E as described in the Custer National Forest Land and Resource Management Plan (1986). The management goal for Management Area E is as follows:

To facilitate and encourage the exploration, development, and production of energy and mineral resources from the National Forest System lands. Other resources would be considered and impacts would be mitigated to the extent possible through standard operating procedures, and, on a limited basis, through special lease stipulations necessary to manage key surface resources. Energy/mineral development would not be precluded by these resource concerns within legal constraints. Efforts would be made to avoid or mitigate resource conflicts. If the responsible official determines that conflicts cannot be adequately mitigated she/he would resolve the conflict in accordance with the management goal and, if necessary, in consultation with affected parties. (Forest Plan, page 58).

CHAPTER II SUMMARY OF PROPOSALS AND ALTERNATIVES

This chapter summarizes the proposed action submitted by SMC and the alternatives to the proposed action, including the no-action alternative. Alternatives have been developed and refined in order to resolve important issues. Based on interdisciplinary meetings and the public scoping process, the issues were further defined. The following sections and chapters identify how the alternatives were developed, present descriptions of each alternative and its environmental consequences and identify any mitigation measures required.

A. COMPANY PROPOSED ALTERNATIVE

1. INTRODUCTION

Stillwater Mining Company proposes to connect the East and West mining areas with a haulage drift driven on the 4400 level, developed in part under the Stillwater River. Secondarily SMC may, upon approval of the plan, mine the ore body at and below the 4400 level if and when mineralization is defined.

SMC plans to implement this proposed Amendment in two distinct phases. Phase I would include completion of 4400 haulage level and the diamond drilling necessary to define the mineralization. Phase II would involve implementation of the mining plan below the surface crown pillar.

Mining procedures would follow established and permitted methods as outlined in Section 3.0 of the Amendment 008. and described in the 1992 EIS.

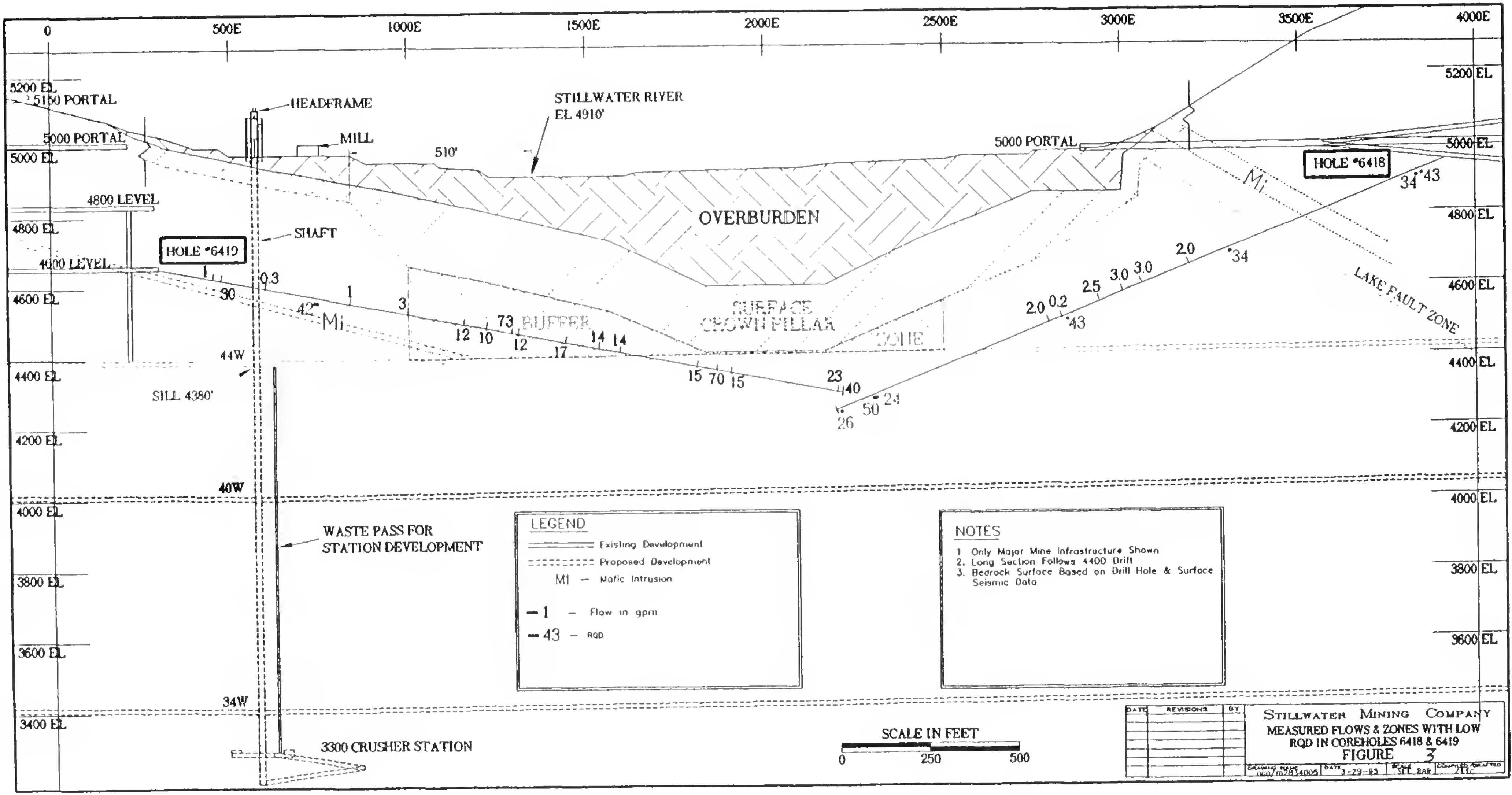
2. PROJECT OVERVIEW

The deposit SMC is mining consists of a single, relatively narrow, steeply dipping vein (reef). The quality of the ore in the vein varies both laterally and vertically. Extensive lateral development is necessary to provide working places (stopes) for mine production (Figure 3).

Access to the ore through surface adits named according to the entry elevation and location on the east or west side of the river. Development to date has been predominately from adits driven from the Stillwater River Valley at and above the 5,000 ft elevation, and east and west along the reef. This has allowed mining above these levels. Currently development extends about 12,000 ft east and 14,000 ft west from the zero reference point near the 5150 West Portal.

The principal reasons for constructing the 4400 haulage level are to:

- Access the primary crusher before milling,
- Distribute workers and materials more efficiently,
- Access additional reserves, and
- Reduce ore and waste handling costs.



0
500E
1000E
1500E
2000E
2500E
3000E
3500E
4000E
5200 EL
5000 EL
4800 EL
4600 EL
4400 EL
4200 EL
4000 EL
3800 EL
3600 EL
3400 EL
5150 PORTAL
5000 PORTAL
HEADFRAME
MILL
STILLWATER RIVER
EL 4910'
510'
4800 LEVEL
SHAFT
HOLE #6419
4600 LEVEL
HOLE #6418
OVERBURDEN
SURFACE
CROWN PILLAR
BUFFER
ZONE
LAKE FAULT ZONE
Mi
44W
SILL 4380'
40W
34W
WASTE PASS FOR
STATION DEVELOPMENT
3300 CRUSHER STATION
LEGEND
Existing Development
Proposed Development
MI — Mafic Intrusion
1 — Flow in gpm
43 — RQD
NOTES
1. Only Major Mine Infrastructure Shown
2. Long Section Follows 4400 Drift
3. Bedrock Surface Based on Drill Hole & Surface Seismic Data
SCALE IN FEET
0
250
500
STILLWATER MINING COMPANY
MEASURED FLOWS & ZONES WITH LOW RQD IN COREHOLES 6418 & 6419
FIGURE 3
DATE 3-29-93

In accomplishing these goals the program would:

- Simplify the surface ore handling system,
- Establish the underground infrastructure necessary for future mining,
- Reduce transportation distances for personnel, ore, and waste rock, and
- Reduce environmental impacts associated with surface transport.

Under amendment 008, a development program to provide sufficient stopes for the mine to supply an average of 2,000 tons of ore per day to the concentrator is being implemented. As part of this program, development is being extended below the existing workings.

The shaft sinking program commenced in October 1994. The shaft, primary crushing, and hoisting facilities are to be completed in 1996. Improved efficiencies in the handling of ore and waste rock would occur after completion of the shaft system. Ore and waste would be transferred via muck raises to selected levels for haulage by rail to dumps and passes feeding the primary crusher located at the shaft complex. After hoisting, ore would be transferred to a surface storage bin or stockpile and fed to the mill.

The 4400 level has been proposed to transfer waste and ore from the east side of the mine with the installation of a track haulage system. The haulageway would connect to the westside shaft crusher and

hoisting facilities. Waste and ore would be transferred via internal passes to the underground crusher for hoisting to the surface.

It is expected that the 4400 haulage level could be completed in approximately six to eight months after approval. Mine development and production within this block would take place over many years and is largely dependent on the grade and vertical extent of the ore body.

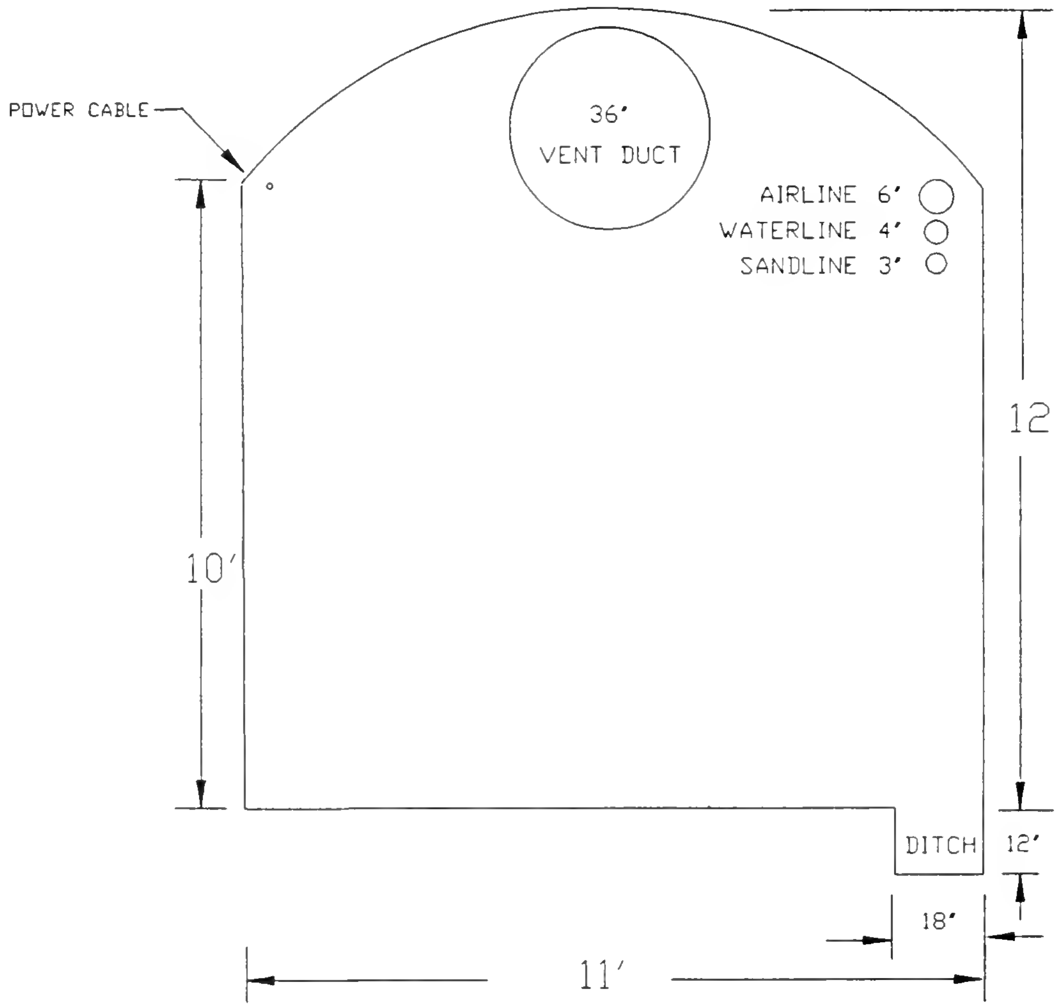
No additional personnel would be required aside from those approved under the SMC 2000 Plan of Operations.

3. DEVELOPMENT AND MINING PLAN

a. <u>Haulage Development</u>

Levels developed from the shaft would be driven using rail or trackless equipment. These levels would also be used to access the ore. Beneath the Stillwater Valley the proposed 4400 haulage level would be the uppermost haulage level. The general layout of the main haulage levels is shown in Figure 3, while Figure 4 gives a typical cross-section through a haulage level.

As levels are established from the production shaft, raises would be developed to allow transfer of ore and waste to selected levels for rail haulage to the shaft area. All material would be handled in this way except for waste above 5000



NOTE: LOOKIN EAST

FIGURE 4

STILLWATER MINING CO.
TRACKLESS HAULAGE LAYOUT

4400 FWL

DATE: 03/10/95

East level which would continue to be truck hauled on surface and incorporated into the east side visibility berm.

Haulage from all transfer levels to the shaft would be by diesel locomotives. Transfers would be made on selected levels, nominally 3400, 4000, and 4400, for haulage by locomotives and mine cars.

b. Mining Methods

Stillwater Mining Company intends to continue to make improvements to mine safety and efficiency. As new technology becomes available and experience is obtained with various mining methods, the safest and most cost effective mining method would be employed.

Mined out areas would continue to be backfilled with mine waste rock and/or mill tails. Backfilling of mined out areas reduces surface storage costs for mill tails and waste rock. In addition, backfill provides wall support and is thus a key element in SMC's ground control program. SMC is required to maintain a 20-50 ft surface crown pillar in all areas of the mine (SMC, 1984). Additionally, this amendment maintains a 200 ft surface crown pillar in the area of the mine beneath the valley floor.

c. <u>Production and Waste Handling</u>

Ore produced from the east and west mining areas would be transported underground to the crusher station located near the shaft.

Waste produced on or below the 5000 East and West levels would be transported underground to the crusher station. Waste developed above the 5000 East and West level would be delivered to the surface for transport to the crusher station.

Production rates for ore and waste would be unchanged from Amendment 008. In addition, no increase surface disturbance is proposed as part of this Amendment.

d. <u>Surface Crown Pillar and Buffer Zone</u>

SMC has set aside an underground area designated as surface crown pillar and a buffer zone. The surface crown pillar or crown pillar, is a zone of overlying rock between the haulageway and the alluvial aquifer. SMC has designed the pillar, as shown in Figure 3, to include a designated buffer area of additional thickness underneath the Stillwater River to further reduce the possibility of any impact. During the construction of the 4400 haulage level, this buffer zone would be maintained and excluded from the Phase II mining plan. However, in the future, SMC may request that this zone be added to the mining plan. This request would be based upon operating experience in this area and definition drilling to substantiate ore reserves, establish expected

stability factors, and demonstrate the absence of significant water inflows.

4. Monitoring

SMC would install a well cluster designed to monitor vertical gradients in the Stillwater Valley aquifer. A discharge of alluvial groundwater to the haulage would result in changes in the vertical gradients of the alluvial aquifer.

The cluster would be comprised of three wells completed at different depths in the alluvial aquifer and the underlying bedrock.

In addition SMC would monitor 4 existing wells, MW-T2A, MW-11A, MW-9A, and MW-20A, shown in Figure 2. Static water levels would be monitored on a monthly basis.

SMC would also measure:

(a) Ditch flow rates and response of surface monitoring wells, on a weekly basis during the development stage.

(b) Flow rates from probe holes.

During construction of the haulage level and during mining, a program of surface subsidence monitoring would be carried out underground. This would allow unusual or excessive movements to be noted, providing a warning prior to any potential significant surface disturbance. The following monitoring program is proposed for those portions of the 4400 level haulage beneath the surficial soils of the Stillwater River:

(1) Visual Monitoring

Underground conditions would be systematically monitored based on a number of visual observations. This monitoring would be the responsibility of the section foreman. The following information would be recorded in addition to standard mine procedures:

- the occurrence of any stuck steel or blasthole closure; the position, depth and probable cause,

- the amount of scaling effort,

- type and density of support installed, and

- the condition of the support along the length of the haulage. Where support shows signs of undue loading, senior mine staff would be informed immediately.

This review would be carried out weekly.

The geology of the advanced face would be mapped and the following information would be recorded:

- rock type,

- number of joint sets,

- presence or absence of any faulting,

- fracture frequency and condition,

- groundwater inflow,

This information would be used to rate the rock at the face according to rock quality using standard rock mass classification techniques. A record of geology and rock quality would be maintained for review by senior mine staff and agency specialists.

(2) Instrumentation and Reporting

Ground movement would be monitored using Ground Movement Monitors (GMM) and convergence measurements. Convergence measurements involve recording the relative displacement between studs installed in the back and walls using an accurate tape measure or convergence rod.

Convergence stations would be installed every 300 feet within the buffer zone area of the 4400 haulage level. Convergency measurements would be carried once a week during active mining. If over a period of 4 weeks no movements are detected, the measurement interval may be increased after review by senior mine staff and consultation with the agencies.

GMM may be installed in the back where poor quality rocks are encountered. The location for the GMM would be established by senior mine staff after inspection of ground conditions. GMM would be monitored until it is established that no further significant movement is occurring.

Data would be presented in tabular and graphical format to ease in interpretation of results, and would be submitted to the agencies on a quarterly basis during the 4400 haulage development.

(3) Surface Subsidence

Survey monuments would be located along the strike of the underground workings crossing the Stillwater valley. These monuments would be monitored and checked periodically for changes due to subsidence.

(4) Underground Monitoring

The excavation of the 4400 haulage level would be treated as a special drifting situation. The following procedures would be used.

Daily water conditions at the face would be recorded and the ditch flow rate measured and compared to the expected flow rate. This would entail installing V-notch weirs at strategic locations. The plot of flow would provide an indication of increasing/decreasing rate change with time.

Along the 4400 haulage level within the buffer zone, probe holes would be advanced in front of the mining face. These holes would be at least 80 ft long and overlap the previous probe hole by a minimum of 20 ft. These holes would be drilled in such a manner to allow the shutting in of any water flow or the injection of grout. The probe

holes would be drilled from the advancing face or from a drill station parallel to the direction of advance. Monitoring of the V-notch weirs and probe holes would be conducted on a weekly basis and the results reported to the agencies on a quarterly basis during the construction and development phase of the project. The agencies would be notified of flows which are in excess of 100 gpm if they persist for an extended period (7-10 days). In such instances, SMC would inform the agencies of the location and corrective measures taken in dealing with such flows.

Decisions on whether to grout or not would be based on a number of site factors including:

- The amount of uncontrolled water expected to flow into the haulage. This value is obtained from monitoring the quantity of water flowing from the probe holes, and pro-rating for the haulage excavation; and

- The consequences of developing through the anticipated inflow (volume of water, discharge limits etc.)

The action taken would be based on the criteria shown in Table 1.

Table 1
Action Criteria

Water Flow Category	Flow Rate	Action
1	< Ditch capacity (20 gpm)	None

2	> Ditch capacity[1] (20 -50 gpm)	Deepen ditch Increase sump capacity Increase pump capacity
3	>> Ditch capacity (Point inflow > 50 gpm)	Stop and grout
4	>> Ditch capacity (Area inflow > 150 gpm)	Stop and cover grout, retreat and cover grout
5	Direct connection to large water source (e.g. Surface aquifer)	Bulkhead and re-excavate

[1]A two foot wide, one foot deep ditch excavated at a grade of 1 percent could handle approximately 50 gpm of flow when full of water. Changing the size and/or grade of the ditch affects the maximum flow rates.

5. <u>Grouting</u>

The grouting strategy is based on the management of any water inflow to meet stated criteria. Grouting can be carried out either ahead of the advancing face of the 4400 haulage (cover grouting) or at any time after the haulage has progressed beyond the area of inflow. Which approach is adopted would depend upon the volume of inflow at that particular location, the amount of water already being sent to mine sumps.

6. <u>Bulkheads</u>

Bulkheads would be installed only if high inflows are encountered that cannot be effectively controlled by grouting. Detailed construction drawings would be prepared before the 4400 haulage level advances underneath the Buffer Zone. As the haulage is extended potential bulkhead locations would be selected (based on ground conditions, etc.). All necessary materials for bulkhead construction would be maintained at the mine.

Two types of bulkheads may be required:

- Temporary bulkheads to buy time in case unexpected high flows are encountered, and

- Permanent bulkheads, which prevent further access to the region beyond the bulkhead.

The most conservative approach is to design a permanent bulkhead for the full hydrostatic head. The bulkhead would be positioned such that there would be at least 200 ft of bedrock above it. This avoids low cover where open fractures, and therefore an increased chance of leakage, could be expected. The bulkhead would be located in competent ground which is not excessively fractured or broken.

B. NO ACTION ALTERNATIVE

The no action alternative would include maintaining the current surface haulage methods. East side ore would be trucked across the road to the west side, dumped through an ore pass to the bottom of the shaft for crushing, then transported back to the surface ore stockpile. As production increases to 2000 tpd, increased truck traffic and surface disturbance would result.

CHAPTER III AFFECTED ENVIRONMENT

A. GEOLOGY

1. General Geology

The ore body within the reef is contained in a tabular (reef) zone within a suite of ultrabasic intrusive rocks. The ore zone extends generally east-west and dips between 60 and 90 degrees. Mining widths vary from 4 ft to greater than 30 ft (ballrooms). The zone is influenced by faulting and shear zones associated with the ore. The continuity of the ore zones varies considerably along the strike and dip.

The reef consists of a number of rock types of varying strengths. The ore lenses vary considerably with regard to their location within the reef. Position is especially important with regard to wall rock behavior. In some areas the ore has been highly sheared, particularly weak and likely subject to degradation when exposed. In other areas the ore rock is highly competent.

The main hangingwall and footwall rocks are norites. These are generally strong, moderately jointed rocks. A more detailed description of the geology is found in Section 2.3 of the Plan of Operations.

2. 4400 Level Geology

The 4400 haulage level would be driven to the south and essentially parallel to the reef complex. This drift

would be located within generally competent footwall rock approximately 100 feet south of the north hangingwall contact of the reef.

Only two regional-scale faults were observed in the investigation coreholes. The Lake Fault zone, an associated diabase dike, and the probable South Prairie Fault zone were intersected by hole No. 6418 (Fig 3). Evidence of the Stillwater Valley Fault, was not observed. Intersections between the reef complex and the investigation coreholes occurred along the same trend as the complex on the west side of the river, these intersections showed no displacement indicative of a strong cross fault in the Stillwater Valley.

3. Rock Fabric

Generally the footwall rocks are competent and have a blocky appearance. No ground control problems have occurred in the footwall rocks of either the east or west mining areas that could not be handled by conventional support techniques.

Three main fracture sets have been observed:

A. Northwest strike, North dip

B. East-West strike, sub-vertical dip

C. North (+/-20) strike, sub-vertical dip

Fracture sets A and B are associated with the bedding, are typically tight and conduct little or no water. Some of these features could flow at very low rates as long as they are connected to a source of recharge.

Fracture set C is typically open and a good conductor of water. The volume of water inflow from these features is limited primarily by their connection to a source of recharge. They are typically connected only to a limited source of water. When intersected, type C fractures typically flow at a high rate for a short period of time after which they either dry up completely or continue to flow at a much reduced rate.

4. <u>Rock Mass Quality</u>

Design of underground openings are based on a number of well-established empirical and semi-empirical rules. These rules enable estimates to be made of the rock mass strength, expected mining conditions and support requirements on the basis of a detailed description of the rock mass.

The rock quality (using Barton's "Q" classification) from bore holes drilled parallel to the haulage are shown in Table 2. The location of the bore holes are shown in Figure 3.

TABLE 2
ROCK QUALITY

Drill Hole Section	Rock Quality Rating (Q)
Hole 6418 Footwall Rock (0-~700 ft)	Fair
Hole 6418 Hangingwall Rock (~700 - 1,0964 ft)	Poor to Fair
Hole 6419 Footwall Rock (0-1,950 ft)	Fair to Good

Though exceptions to the above categories exist, they are generally localized, short (10 to 20 ft) intervals

of lower than typical rock quality. The core logs show that these intervals are mainly associated with minor fault zones.

5. Rock Strength and In-situ Stress

Intact rock strength was estimated using data from compressive strength tests conducted during the initial mine permitting. Results indicate that the majority of rock in the coreholes could be classified as medium strong to very strong, having an average unconfined compressive strength of 15,000 psi. Estimates of the in situ stress conditions are less than 1,000 psi. Hence, the inherent strength of the host rock is well in excess of the stresses expected at the proposed 4400 haulage level.

6. Seismicity

The project site is in a region of low to moderate seismic activity, on the border between Seismic Zones 2 and 3 (USACE, 1970). Previous investigations have used a peak seismic ground acceleration of 0.18g, based on regional faulting (IECO 1986).

B. HYDROLOGY

1. Surface Water

Surface water features near the Stillwater Mine are dominated by the Stillwater River which flows north through the mine site. Several small tributaries flow into the Stillwater River in the mine project area and are considered sub-alpine streams. These streams are

Verdigris Creek, Nye Creek, and Mountain View Creek. Most other drainages within the southeastern portion of the Beartooth Mountains also flow into the Stillwater River.

Flows in the river usually peak during June or July from snow melt and increased spring precipitation. Roughly three-fourths of the annual runoff occurs in May, June, and July. Stream flows in the Stillwater River have been measured since 1979 by the USGS at a stream gauging station located at the bridge above Nye Creek near the Stillwater Valley Ranch percolation ponds. Annual mean flow in the Stillwater River is 367 cfs (164,000 gpm). The highest monthly mean flow 1,758 cfs (790,000 gpm) occurs in June and the lowest monthly mean flow 50.7 cfs (22,700 gpm) occurs in March. The 7-day, 10-year low flow for the Stillwater River at the USGS gauging station is estimated to be 31.1 cfs (14,000 gpm). The maximum peak flow record was 6,400 cfs (2,870,000); the lowest recorded flow was 16 cfs (7,200 gpm), less than 1 percent of the maximum flow.

The upper Stillwater basin has a rough topography (maximum relief is 6,400 ft) and a high variation in average annual precipitation (20 to 40 inches per year), which account for the wide range in river flows and the high spring runoff.

2. Groundwater

The overburden in the Stillwater River Valley is over 300 ft thick in places and is permeable (10^{-1} to 10^{-2} cm/s). The groundwater level in the valley is close to the level of Stillwater River and fluctuates from 3 to

5 ft annually following the yearly runoff cycle. This suggests that:

- There is a hydraulic connection between the river and the groundwater; and,

- There is a significant amount of flow occurring through the overburden adjacent to and beneath the river bed.

Observations of intact rock in the mine workings suggest that primary permeability is negligible. Inflow of groundwater to the mine workings is considered to be controlled by fractures (faults, joints, etc.). The volume of groundwater inflow to the mine workings through these fractures depends on:

- The permeability of the fractures, and

- How well the fractures are connected to a source of recharge.

Most of the fractures observed in the mine are tight and do not conduct significant groundwater. Some open features have been observed, however, that could carry significant flows. The east side of the mine workings are noticeably wetter than the west side. This can be partly attributed to the thicker overburden cover above the eastern workings, which has a greater storage capacity for water. In addition, the fractures on the east side appear to be slightly more vertical. This may play a role by providing better connections between the workings and the overlying surficial soils.

3. <u>Groundwater Quality</u>

The groundwater quality within the project area has been thoroughly documented in annual water quality reports to the agencies and in previous Environmental Impact Statements (EIS) such as SMC 2000. These reports document the generally good quality of the groundwater.

4. Underground Inflow

The Stillwater 2000 Environmental Impact Statement (EIS) anticipated water inflows to the underground workings to be in the range of 1,900 gpm. SMC's Nondegradation Report for the 4th quarter of 1994, shows average adit water discharge at 758 gpm.

Two core holes have been drilled along the proposed 4400 haulage. The final flow rate reported from the west corehole was 46 gpm. This rate represents the total contribution of all flowing features along 1,951 ft of corehole. In general, there are very few correlations's between flowing intervals and changes in lithology or structural features.

5. Interception of water from No Name Creek

In April of 1987, Stillwater Mining Company (SMC) received an exploration permit to investigate ore reserves on the east side of the Stillwater River. During May 1988, SMC reported to the agencies that increased adit water inflows had been encountered in the exploration adit and that it was likely that the increase was attributable to the interception of ground water flows feeding No Name Creek. Additional monitoring requested by the agencies and an investigation conducted by the Hard Rock Bureau and

DNRC's Water Rights Bureau confirmed that No Name Creek had indeed been intercepted by SMC's exploration activities.

Monitoring which had been initiated at the beginning of exploration activities and had been required by the agencies in approving the exploration project, indicated that the flows from No Name Creek averaged approximately 161 GPM during the seven months preceding the interception. Subsequent water rights investigations estimated that in a period of normal precipitation, the mean annual flow in No Name Creek was closer to 1.0 CFS (450 GPM). Currently, east side adit flows, as measured through the east side clarifier, are averaging approximately 650 GPM. SMC estimates that of the 650 GPM exiting the east side adit, approximately 150 GPM can be attributed to the interception of No Name Creek. The upper reaches of No Name Creek still flow, however, the flow has been reduced to a level where the entire flow now infiltrates into the ground before reaching the valley floor.

SMC currently holds the beneficial use rights on No Name Creek and east side adit waters. These waters are currently put to beneficial use in the milling and mining process as make-up water. Additionally, these waters are disposed of through SMC's Land Application and disposal system (LAD) during the summer months and are percolated into the ground water aquifer during the winter months.

CHAPTER IV ENVIRONMENTAL CONSEQUENCES

A. EFFECTS OF COMPANY PROPOSED ALTERNATIVE

1. GEOLOGY

a. Surface Crown Pillar Stability

The stability of crown pillars is influenced by a number of factors, including:

- Size of the pillar,
- Groundwater,
- Geology and rock quality,
- Stope geometry, and
- Stress regime.

Due to the complex inter-relationship between these parameters, no general analytical solutions for design of surface crown pillars are available. Empirical methods of design are normally used based on case histories of other mines.

Adequately sizing the surface crown pillar to ensure it remains stable both during its operating life and after closure is very important.

From a rock mechanics perspective, crown pillar design must satisfy two general requirements. The first is that a stable crown pillar geometry must be provided. The second is that stability of the underlying excavations must be maintained, since stope instability could change the crown pillar geometry.

The first requirement specifies that a stable crown pillar geometry must be provided. This issue can be addressed by examining typical failure mechanisms for crown pillars. These mechanisms are often structurally controlled by joints or faults. No faults were identified during the investigation which would cause overall instability of the surface crown pillar.

The planned width of the 4400 haulage level is 12 ft while the average thickness of the surface crown pillar is 200 ft. This results in a thickness to span ratio for the pillar of 16. It is generally accepted that when this ratio exceeds 10 there is sufficient rock mass and confinement to result in an "infinitely" strong pillar.

As an additional check, an empirical relationship for design of crown pillars (Carter, 1990) has been applied. Parameters describing pillar geometry and rock weight are combined to determine a factor called the "Scaled Critical Crown Pillar Span." This factor is plotted against the estimated rock mass quality on a stability analysis chart, derived from a large number of case histories.

The analysis indicates that the proposed crown pillar dimensions are adequate even at a span of 35 ft. The long-term stability of the pillar is not considered to be an issue, particularly because SMC proposes to backfill the 4400 haulage level where it is adjacent to the base of the surface crown pillar at closure. In addition, all stopes would be backfilled upon completion of mining.

Groundwater

A large number of mines operate immediately below bodies of water (lakes, rivers etc.), many in rocks of similar quality to those at Stillwater with substantially smaller surface crown pillars than is currently proposed. Thus, there is substantial precedent for SMC developing the 4400 haulage level beneath the Stillwater River. Table 3 provides information on a number of these mines with the 4400 level haulage at SMC shown for comparison purposes. The hydrology discussion provides additional information on groundwater.

Table 3
Selected Mines Operating Beneath Bodies of Water

Mine	Location	Thickness/span
Chisel	Manitoba	0.94
Eagle Point	Saskatchewan	3.3
Kiena	Ontario	4.4
Spruce Point	Manitoba	2.4
Namew Lake	Manitoba	0.6
Westarm	Manitoba	12.0
Lakeshore	Ontario	2.1
Tech Hughs	Ontario	3.3
Stillwater Mining Co.	Montana	16.0

Table 3 could be quite extensive if all the mines that actively mine under bodies of water were listed. In addition, there are many civil projects that have excavated openings immediately below bodies of water. The Channel Tunnel is probably the most famous but almost every major city in the US built around a river has a road or rail tunnel under the river.

Stope Geometry and Rock Quality

Though the surface crown pillars have been sized to maintain control during active mining, long-term stability can only be assured if the stopes immediately beneath the surface pillars are backfilled. Otherwise, raveling of the excavation backs may occur over time.

Large amounts of surface disturbance, easily noticeable to the naked eye, can be caused by shallow mining. This type of subsidence is difficult to predict, and is initiated when the roof of a mined void fails and the material in the roof falls into the void. Because the material is disturbed when it reaches the floor, it takes up more volume than the in-place material. As a result, there are three possibilities when roof failure occurs:

1. The roof caves until a stable configuration is achieved, either because of more stable geometry is achieved (for example an arch where a flat roof had existed before), or because a stronger material is encountered in the roof strata; or

2. The roof may cave until the surface is reached, in which case disturbance of the surface would result; or

3. The material which has fallen from the roof expands enough to fill the original void plus the new void created by the fall itself, in which case the roof would be supported by the collapsed roof rock, and no further caving would occur.

Of these possibilities, the only one that is readily quantified is the last. Development of surface disturbance cannot occur if the depth to the mined void being considered is greater than a critical depth, which is that depth at which the failing material

swells to entirely fill the available void. This depth is a function of the swell factor and the excavated height. Thus, to consider surface disturbance potential, one must consider both roof failure and the nature of the overburden material.

Roof span failure may occur at any time in any mine. It is most likely to occur in weak rock and in areas with wide spans. In general, it occurs soon after (or even during) mining.

The 4400 haulage level would be driven through generally strong, competent rock of fair to good quality. Zones of poorer quality rock are anticipated but they are expected to be limited in extent.

Given rock strengths in the mine area, short-term instability is unlikely. Even in mines which have been stable for many years, however there remains a finite probability of span collapse. This probability cannot be predicted with any degree of accuracy or confidence.

As swell factors in most rocks are about 20 to 30 percent, the highest risk of failure appearing at surface is when the depth of cover is less than about three to five times the excavated height. At ten times the excavated height, only in very exceptional circumstances should a void migrate through to the surface.

The 4400 haulage level would be fully supported and maintained during its operational life. Any poor ground would thus be quickly re-habilitated and secured.

Placing backfill in mine stopes would effectively limit any slough that occurs assuring the long-term stability of the surface crown pillar. By reducing the amount of void beneath the bottom of the surface crown pillar, the thickness of crown pillar

which can fail before becoming self supporting due to the swell of the fallen material is greatly reduced.

Backfilling is an integral part of the mining method at Stillwater. Therefore all stopes would be filled as part of the mining process. This would greatly reduce the void height beneath the surface crown pillar and ensure its long-term stability.

Upon cessation of mining SMC would backfill portions of the haulage, thus effectively mitigating against any local roof collapse breaching the surface crown pillar.

Stress Regime

Given the estimated stress regime, the stability of the back and walls of the haulage level would be controlled primarily by structure. Stress induced fracturing is not considered an issue.

The majority of the haulage is stable and, assuming good blasting practices, would only require spot bolting. However, SMC proposes to systematically support the haulage. This support would be intensified, as appropriate, in areas of poor ground.

Seismic

Woodward-Clyde Consultants (WCC) reviewed the previous seismic investigations and available seismic data for the region. They completed a site-specific analysis based on current seismic data and procedures. Their analysis indicates that the previously developed seismic design parameters are conservative for this site (WCC, 1994).

2. HYDROLOGY

a. Surface Water

(1) Effects on River Flow and Groundwater Levels

The predicted rate of inflow to the haulage way (200 gpm) should not have an impact on flow in the Stillwater River or groundwater levels in the valley. In the valley above the proposed haulage, the Stillwater River is a losing stream, that is, the stream discharges to the groundwater. Approximately 3200 feet downstream from the surface trace of the haulage, the stream begins to gain, that is the groundwater discharges to the stream. A lowering of the water table above the haulage near the river would cause an increase in the amount of water that the stream loses in the effected reach. For example, assuming that approximate 800 feet of stream length above the haulage would be affected by leakage of water from the alluvial aquifer to the haulage tunnel, each foot of water table decline would cause the river to lose an additional 250 to 350 gpm of water to the aquifer. This reduction in flow would not be manifested very far downstream because the water intercepted in the haulage would be pumped to the surface and land applied or percolated back into the aquifer immediately downstream from the affected reach. Recharge of the aquifer through land application and percolation would cause an

increase in water table elevation and a consequent increase in groundwater discharge to the gaining reach of river downstream from the USGS gaging station.

In summary, if the haulage causes a lowering of the overlying water table, the volume of water leaving the stream and entering the aquifer in the losing reach would be roughly balanced by the volume of water entering the stream in the gaining reach, with no net effect to stream flows downstream of the mine property.

(2) <u>Quality</u>

Groundwater quality is not expected to change following the implementation of this proposal. Mine production rates and the associated nutrient loading from mining activities would not be increased by way of this amendment and would not exceed the levels analyzed in the SMC 2,000 EIS. (See chapter 4.2 of the SMC 2,000 EIS - 1992)

b. Groundwater

(1) <u>Water Inflow</u>

The chief concern for the proposed haulage level is the possible existence of a highly conductive feature or fracture zone that is well connected to the overburden in the Stillwater Valley. Lithologic and flow

information from the investigation coreholes do not indicate the existence of any such features. The flows observed from these coreholes were all associated with discrete features of local extent.

Inflows to the proposed 4400 haulage level are expected to be primarily through fracture sets A and B described in Chapter III. These sets may have some connection to the overburden soils, but their low permeability would limit the inflow volumes. Inflows from these features are expected to be on the same scale as the flows observed in the East Side Mine.

Given that flow in the bedrock is fracture controlled, it is not possible to accurately predict the peak inflows that would be encountered by the 4400 haulage level. The peak flows encountered by the investigation coreholes dissipated in less than a day indicating that the flowing features were not well connected to a source of recharge. Therefore the peak flows are not considered representative of the long term inflows to the 4400 haulage level. The steady state flow measured from the entire west side corehole provides a more reliable measure of the long term inflows.

The expected rate of inflow to the 4400 haulage level was estimated using standard methods. This analysis suggests that steady state inflows to a 4,000 ft long section of

the 4400 haulage level would be approximately 200 gpm. This estimate does not consider the effects of a grouting program.

The investigation coreholes did not encounter any types of flowing fractures which were not amenable to grouting. Thus the potential for impact would be further reduced given the proposed management program which includes a grouting program. Utilizing the control measures permitted in Section 8 of the Plan of Operations, it is highly unlikely that operational flows would exceed those predicted in the 2000 EIS.

Effects to the Stillwater River from the proposal, similar to the interception of No Name Creek are unlikely. The East Side adit was driven relatively close to No Name Creek in an area of lightly fractured rocks. In contrast, the proposed haulage will be driven 200 feet below the bedrock surface and 500 feet below the Stillwater River. Therefore effects to the River are not expected.

Currently, SMC has four groundwater monitoring wells (Figure 2) which may be useful in the monitoring of groundwater levels during development of the 4400 haulage level and during Phase II mining within the valley ore zone. These wells are located on both sides of the river and straddle the trace of the 4400 development. It is anticipated that the data collected over the last nine years of mine operation should be

useful in documenting significant changes in groundwater flows.

SMC would also install a well cluster designed to monitor vertical gradients in the aquifer. A discharge of alluvial groundwater to the haulage would result in changes in the vertical gradients of the alluvial aquifer.

B. EFFECTS OF NO ACTION ALTERNATIVE

The no action alternative would include maintaining the current surface haulage methods. As production increases to 2000 tpd, increased truck traffic and surface disturbance would result. Additionally this alternative would result in increased fugitive air emissions, increased noise and increased visual impacts with the expanded production. These effects are described in detail in 1992 EIS (MDSL-USFS, 1992).

C. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Production of ore under the Stillwater River Valley would be a permanent and irreversible commitment of the resource.

D. CUMULATIVE IMPACTS

There are no identified cumulative impacts from either alternative.

LIST OF PREPARERS

Coordination

Sandra J. Olsen, DEQ
Robert C. Winegar, DEQ
Mike DaSilva, DEQ

Water Resources

Joe Gurrieri, DEQ

Engineering & Geology

Peter Werner, DEQ
Steve Monninger, DEQ

Glossary

Crown Pillar	The mass of rock that overlies an underground opening.
Dike	A tabular igneous intrusion that cuts across the bedding of the local rock.
Drift	A horizontal underground opening driven along an ore vein.
Footwall	The underlying side of an orebody.
Hangingwall	The overlying side of an orebody.
Haulageway	A tunnel used for transporting ore or waste rock.
Portal	The mouth of an adit or tunnel.
Reef	A common term for a tabular ore deposit enclosed in rock of differing composition.
Shaft	A vertical excavation through which a mine is worked.
Stopes	An underground excavation formed by the extraction of ore.

REFERENCES

Carter, 1990, A new Approach to Surface Crown Pillar Design, Golder Associates.

International Engineering Company, Stillwater Tailing Impoundment Engineering Report, Vol. I & II, February 1986.

Montana Department of State Lands and USDA Forest Service, Final Environmental Impact Statement, Stillwater Mine Expansion 2000 TPD, September 1992.

Montana Department of State Lands and USDA Forest Service, 1985, Final Environmental Impact Statement, Stillwater Mining Company, Stillwater Project. December.

Montana Department of State Lands and USDA Forest Service, 1989, Revised Preliminary Environmental Review and Environmental Assessment, Stillwater Project, East Side Adit Development, February.

Stillwater Mining Company, 1984, Application for an Operating Permit.

Stillwater Mining Company, 1990, Mine Expansion 200 TPD, Application to Amend Permit No. 00118. December.

USACE, 1970, Engineering and Design, Stability of Earth and Rockfill Dams, EM 1110-2-1902, April.

USDA Forest Service, Custer National Forest Land and Resource Management Plan, 1986.

Woodward-Clyde Consultants, Permitted Crest Elevation 5,111 Feet Tailing Impoundment Design Engineering Report, March 1994